Detection of internal quality in kiwi with a new optical technique (TDRS)

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A compact system based on time-resolved diffuse reflectance spectroscopy (TDRS) has been developed to measure internal fruit quality parameters and has been applied to the non-destructive estimation of firmness, sugar content and acidity of kiwifruits. This new optical technique, developed in medical applications and related areas, provides a complete optical characterisation of a diffusive sample as it estimates at the same time and independently the light absorption inside the tissues and the scattering across them. The working principle of the technique is the analysis of the attenuation and broadening of the time-distribution of the remitted light, and the correct interpretation with a proper theoretical model. This main advantage compared to conventional optical techniques (which are only able to register the global attenuation spectrum) added to the compact, portable prototype developed along a three-year work opens the possibilities of this new measurement method in the food industry.

Initially, a precise laboratory TDRS system, with tuneable VIS & NIR lasers, was applied to different batches of kiwis, in a total number of 170 samples with diverse ripeness stages, to calculate the absorption coefficient (μ_a) and the transport scattering coefficient (μ'_s), in the wavelength range 610-1010 nm.The fruits were tested simultaneously with the TDRS device and with standard fruit measurement equipment Firmness was registered in a texturometer with force/deformation curves, sugar content (°Brix) with a digital refractometer, and acidity by titration. External colour was recorded with a handheld spectrophotometer. All the gathered database was analised combining principal components analysis, clustering techniques, discriminant analysis, and other statistical methods. Links between the TDRS coefficients and fruit quality properties were found and different estimation models were created for the assessment of firmness, sugar and acids in kiwis, using VIS & NIR wavelengths . Classification models provided percentages of correctly classified fruits above 75%, 75% and 70% respectively, showing the interesting potentiality of this technique.

During a second phase, a two-wavelength VIS TDRS prototype was built and used effectively to test new kiwi samples. This instrument was designed to be easy to use and to be handled by an unskilled user. The prototype TDRS instrument was successfully validated. Firmness of kiwifruit was classified correctly for 70% of fruits and compares favourably with the former models. The previous models based on NIR, were superior to the prototype for the classification of sugar concentration for peach and kiwifruit.

References

Cubeddu, R., A. Pifferi, P. Taroni, A. Torricelli, G. Valentini, M. Ruiz-Altisent, C. Valero, and C. Ortiz. 1999. Non-destructive measurements of the optical properties of fruits by means of time-resolved reflectance. *Photonics West '99 - BiOS, Optical Tomography and Spectroscopy of Tissues*

Ruiz-Altisent, M., P. Barreiro, and J. L. García. 1994. Non-destructive quality measurement and modelling in fruits. *International Agrophysics*, n. 8: 445-53.